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Centre number	Candidate number
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Forename(s)	
Candidate signature	

Level 3 Technical Level DESIGN ENGINEERING MECHATRONIC ENGINEERING

Unit 3 Mathematics for Engineers

Friday 18 January 2019

Afternoon

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- pens
- pencils
- simple drawing instruments
- a scientific calculator (non-programmable)
- the formula sheet, which is provided as an insert inside this paper.

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer all questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this answer book. Cross through any work you do not want to be marked.
- Answer to 3 significant figures unless otherwise instructed.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80. There are 50 marks for Section A and 30 marks for Section B.
- Both sections should be attempted.

Advice

- Do not spend too long on one question.
- Read all questions thoroughly before starting your answer.
- Show all working in the spaces provided.

For Examiner's Use			
Question	Mark		
1			
2			
3			
4			
5			
6			
7			
8			
9			
TOTAL			



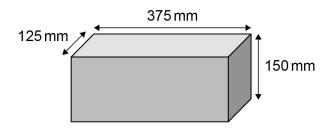
Section A

Answer all questions in this section.

Total for this section: 50 marks

0 1 An engineering company has received an order to manufacture 250 containers as shown in **Figure 1**

Figure 1



Each container is manufactured from six sheets of stainless steel.

0 1.1	Calculate the surface area needed to manufacture the batch of 250 containers. Give your answer to the nearest whole number in m ² [7 marks]	;]
		_
		_
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0 1.2	It takes a CNC welding machine 3 minutes 42 seconds to weld each container together.	Do not write outside the box
	Calculate how much it will cost to weld the whole batch if the company charges £150 per hour for the use of the machine. [3 marks]	
		10

Turn over for the next question

Turn over ▶



0 2	A round steel bar is loaded in tension as shown in Figure 2
	Figure 2
0 2 . 1	The bar has the following dimensions:
	 15 mm diameter 1 m original length 200 GPa Young's modulus Applied tensile load 25 kN
	Calculate the change in length of the bar.
	Answer in millimetres to 1 significant figure. [10 marks]



0 2.2	Use the formula method to solve the following quadratic equation:	
	$x^2 + 6x + 8 = 0$	[3 marks]
	Turn over for the next question	

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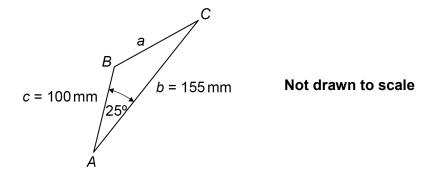
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0 3

A metal template needs to be manufactured, as shown in Figure 3

Figure 3



Calculate the length of side a.

Answer to the nearest millimetre.



0 4	A CNC programmer needs to determine the position of point A in polar coordinates shown in Figure 4	outsi b
	Figure 4	
	Point A (175 mm, 125 mm)	
	Not drawn to scale	
	Convert the Cartesian coordinates into polar coordinates. [5 marks]	

Turn over for the next question



Turn over ►

0	5

Table 1 shows the tightening torque (Nm) of a series of bolts on a machine tool.

Table 1

10.5	10.6	10.5	10.4	10.6
10.4	10.5	10.6	10.5	10.5

0 5.1	Calculate the mean torque value (Nm) of the data set.	[2 marks]
0 5.2	Calculate the median torque value (Nm) of the data set.	
		[4 marks]



0 5.3	Explain how statistics can help the engineering industry in their quality assurance methods/procedures.	Di Oi
	Give two examples in your answer. [4 marks]	
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0 6

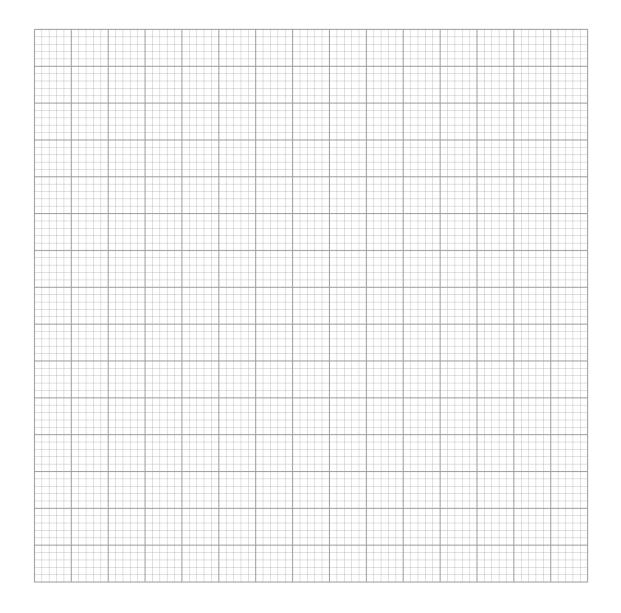
The data, contained in **Table 2**, is wear rate values taken from a turbine's bearing measured over a period of time.

Table 2

Wear rate – microns	5	10	15	20	25	28	31	33	35	36
Time –	0–	1000–	2000–	3000–	4000–	5000–	6000–	7000–	8000–	9000–
seconds	1000	2000	3000	4000	5000	6000	7000	8000	9000	10 000

0 6. 1 Plot a graph of the data set wear rate against time.

[3 marks]





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0 6.2	Explain what is happening to the wear rate between 0 and 5000 seconds.	[2 marks]
0 6.3	Explain what is happening to the wear rate between 5000 and 10 000 seco	nds. [2 marks]
	Turn over for Section B	
	rum ever for econom 2	
	Turn over for Section B	

Turn over ▶



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J	ec	H	O	n	

	Answer all questions in this section.
	Total for this section: 30 marks
0 7	A circular steel shaft is shown in Figure 5
	Figure 5
	Not drawn to scale
	It has the following dimensions:
	 Diameter = 35 mm Mass = 13 200 g Density = 7800 kg m⁻³
	Calculate the length of the shaft to the nearest millimetre. [10 marks]

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8 0	In a pressurised hydraulic system, an engineer uses the following equations:					
	$26 = 7p_1 - 2p_2$ $29 = 6p_1 + 5p_2$					
0 8.1	Calculate the values of the ${\bf two}$ pressures, $\boldsymbol{p_1}$ and $\boldsymbol{p_2}$	[7 marks]				
0 8.2	The pressure in a hydraulic system is 1.25 MN m ⁻²					
	Calculate the force if the area is 0.126 m ² to 4 significant figures.					
	You must show all of your working and include the correct units.	[3 marks]				

Turn over ▶



0 9	The velocity, v , of a robot, t seconds after changing a tool is $(2t^2 + 5)$ ms ⁻¹	
0 9.1	By the use of integration, calculate the distance that the robot has travelled betw $t = 0$ to $t = 4$ seconds.	veen
	Answer to 2 significant figures. [7 I	marks]



0 9.2	Explain what this area represents by showing how you got to this solution.	[3 marks]	Do not writ outside th box
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END OF QUESTIONS



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